PERIODICITY (TRENDS IN THE PERIODIC TABLE) DETAILED NOTES AND SAMPLE QUESTIONS
S4 TERM TWO TOPIC
NEW LOWER SECONDARY CURRICULUM (CHEMISTRY)

Periodicity

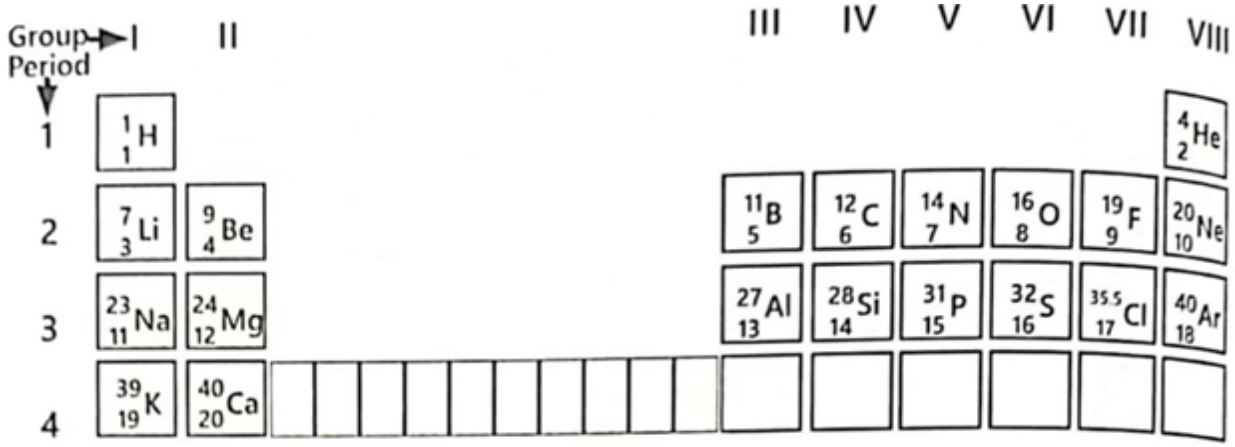
Periodicity is the regular variations in the chemical and physical properties of the elements with increasing atomic number in the periodic table.

Periodic table is a tabular chart that shows the arrangement of chemical elements in order of their atomic numbers. The elements are arranged in rows(horizontally) and columns(vertically).

When the elements are arranged by atomic number, they show periodicity.

The way elements are arranged in the periodic table gives rise to different trends in the properties of the periodic table.

The arrangement of the first 20 elements in the periodic table



There are 4 periods and 8 groups in the periodic table.

How elements are arranged?

1. The elements are arranged in rows and columns.
2. Elements in the same row have the same number of energy levels
3. Elements in the same column have the same number of electrons in the outermost energy level.

ACTIVITY

Explain the following terms?

(a) periods

(b) groups

(a) Periods are the horizontal rows running from left to right.

(b) Groups are the vertical columns running from top to the bottom of the periodic table.

Explain the principle underlying the arrangement of elements into groups and periods in the periodic table.

Elements are arranged in the periodic table in order of their atomic numbers in groups and periods, so that elements with similar atomic structures appear in the same group

Introduction to trends in the properties of elements in the periodic table

Arrangement of elements in the same group

Elements in the same group have the same number of electrons in their outermost energy level or shell.

This can be shown by their electronic configurations.

Consider group I elements, their atomic number and electronic configurations

Element	**Atomic number**	**Electronic configuration**
Lithium	3	2:1
Sodium	11	2:8:1
Potasium	19	2:8:8:1

Arrangement of elements in the same period

- Elements in the same period have the same number of energy levels.
- From one element to another across the period, the number of electrons in the outer most energy level increases by one.

Consider elements in period 2

Period 2 Elements	Lithium	Beryllium	Boron	Carbon	Nitrogen	Oxygen	Fluorine	Neon
Atomic Number	3	4	5	6	7	8	9	10
Electronic Configuration	2:1	2:2	2:3	2:4	2:5	2:6	2:7	2:8

SAMPLE SCENARIO ITEM AND RESPONSE

Andrew who is in S2 class opened his brother's book and read the word Periodic table, groups, and periods. He also found two tables with some figures written from I to VIII across, and others on left hand side from top to bottom 1, to 4. In the second Table some letters were inserted inside the small squares. He wants to learn more from his brother about the periodic table but his brother just copied notes and did not attend class. Andrew has contacted you to help him understand periodic table

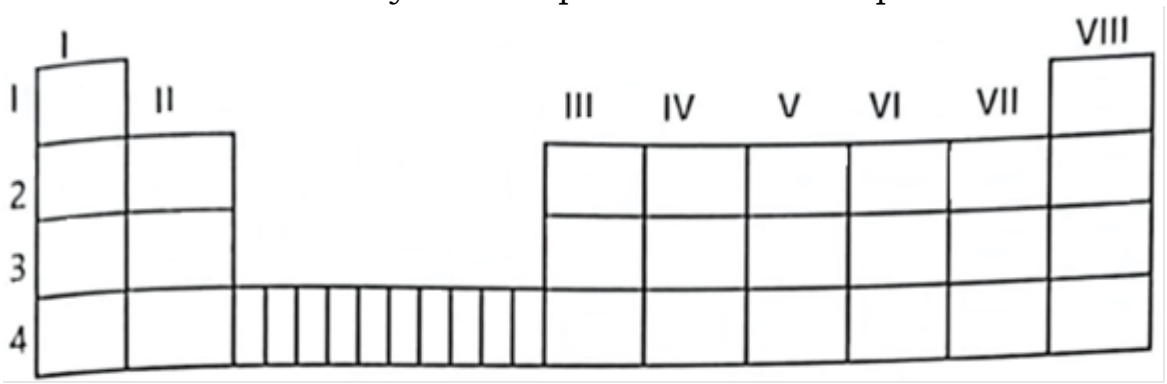


Table 1

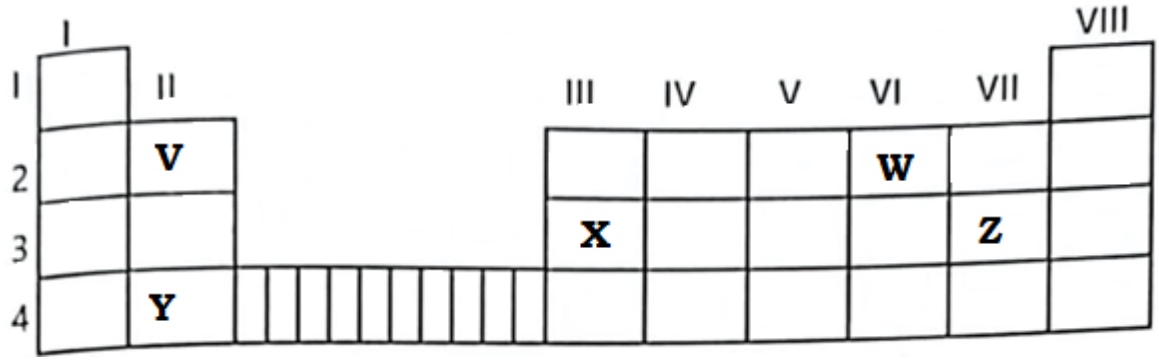


Table 2

TASK:

As a S4 learner of chemistry; explain the following;

1. What the words periodic table, groups and periods mean?
2. What conclusion can you draw about elements in the same;
   (a) Group
   (b) Period
3. Andrew observed that element Z is in period 3 and Group IV of the periodic Table. Help him understand;
   (a) What the atomic number of Z is?
   (b) Write its electronic configuration
4. The electronic configurations of elements V, W, X, Y and Z (the letters are not the actual symbols of the elements) are 2:2, 2:5, 2:8:3, 2:8:8:2, and 2:8:7 respectively.
   The grid below shows part of the periodic Table. Put the letters V, W, X, Y and Z in the grid to show the positions of the elements they represent.

RESPONSES

1. (a) Periods are the horizontal rows running from left to right.

(b) Groups are the vertical columns running from top to the bottom of the periodic table.

2.(a) Elements in the same group have the same number of electrons in their outermost energy levels

(b) Elements in the same period have the same number of energy levels and also from one element to the other across the periods, the number of electrons in the outer most energy level increases by one

3. (a) 14

(b) 2:8:4

4 ***V*** *is Boron(B=5),*

W *is Nitrogen (N=7);*

X *is Aluminium (Al=13);*

Y *is Calcium (Ca=20)*

Z *is Chlorine (Cl = 17)*

TRENDS IN PROPERTIES OF COMPOUNDS OF THE ELEMENTS IN THE THIRD PERIOD

Period 3 elements include the following:

Sodium, Magnesium, Aluminium, Silicon, Phosphorus, Sulphur, Chlorine, and Argon as shown in the table below

Element	**Na**	**Mg**	**Al**	**Si**	**P**	**S**	**Cl**	**Ar**
Atomic number	11	12	13	14	15	16	17	18

Now, across the period, the metallic character decreases from the left to the right.

Trends in the physical and chemical properties of elements in the group and across the periods in the periodic table

At ordinary level, we shall consider the trends below;

1. Atomic radius
2. Metallic character
3. Melting points
4. Boiling points
5. Density.

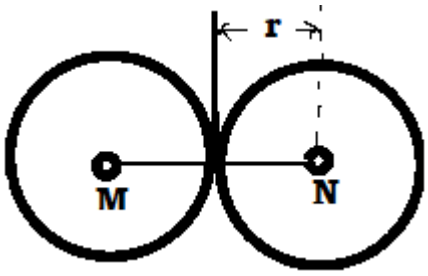
1. TREND IN ATOMIC RADIUS

Atomic radius is the distance between the centre of the nucleus of an atom and its outermost shell.

[**OR**] It can also be defined as the inter-nuclear distance of closest approach between two light atoms of the same element in a bonding situation

[OR]: Atomic radius is half the inter-nuclear distance between two identical atoms of the same element joined together by covalent bond.

Illustratrtion



Distance r is the atomic radius while the Distance **M** to **N** is the inter-nuclear distance between two atoms

[**OR**] It can also be defined as the inter-nuclear distance of closest approach between two light atoms of the same element in a bonding situation

r is the atomic radius of

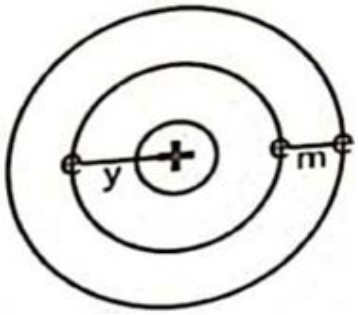
However, it must be noted that it is practically impossible to measure the radius of a single atom than double ones. In a covalent bonding of two identical atoms as shown above, atomic radius is equal to $^{X}/_{2}$ where X is the distance between the two nuclei of the atoms.

Forces within an atom

- Attractive force and
- Repulsive force.

Sample question

Study the structure of lithium and answer the questions that follow.



a) Identify the forces;
   i. **Y –** *The Attractive force*
   ii. **M-** *Repulsive force.*

b) Which one of the forces above operates to;
   i. Decreases the size of an atom
   • *Forces **y** decreases the size of an atom because it pulls it inward*
   ii. Increases the size of the atom
   • *Forces **m***

Trend in atomic radius across the period

- Across the period, the atomic radius decreases to due to the increase in the nuclear charge.

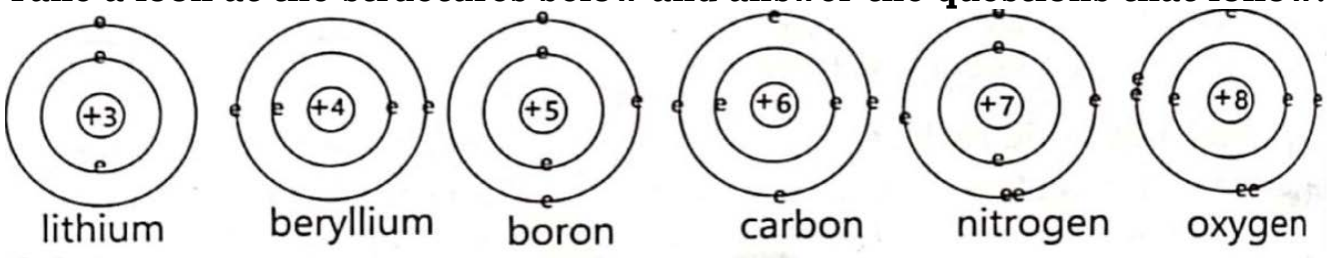
Note

- The lower/smaller the nuclear charge, larger the structure of an atom.

The higher/larger the nuclear charge, the smaller the structure of an atom.

Therefore, the largest atom is the one with the smallest/least nuclear charge and the smallest atom is the one with the largest/highest nuclear charge.

Take a look at the structures below and answer the questions that follow.

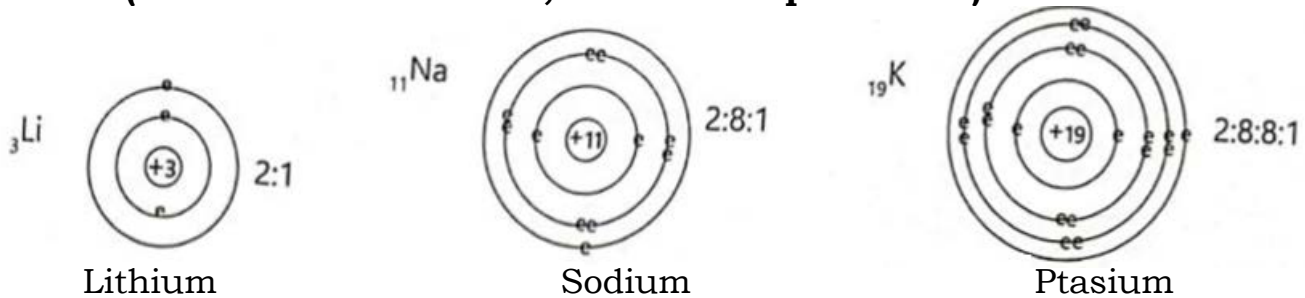


1. Identify the atoms with the largest and smallest atomic radius.
   - Lithium has the largest atomic radius.
   - Oxygen has the smallest atomic radius.
2. Give reasons for your choices in number 1 above.
   - Lithium has the least nuclear charge, therefore, its outer most electrons experience the least nuclear attraction which results in the greatest distance between its nucleus and outermost electrons.
   - Oxygen has the highest nuclear charge; therefore, its outermost electrons experience the greatest nuclear attraction. This results into the smallest distance between its nucleus and the outermost electrons.
3. State the trend in atomic radii of period 2 elements.
   - Atomic radius decreases across the period from the left to the right.

Trend in atomic radius down the group

Atomic radius increases down the group due to an extra shell of electrons added.

Take a look at the structures below and answer the questions that follow. (In the order of lithium, sodium and potassium)



Lithium Sodium Ptasium

a) Identify the atoms with the smallest and the largest atomic radius.

- *Lithium has the smallest atomic radius.*
- *Potassium has the largest atomic radius.*

b) Give reasons for your choices in (a) above.

- *Lithium has the smallest atomic radius because its outermostelectrons are at least shielded from the nuclear attraction.*
- *Potassium has the largest atomic radius because its outermost electrons are most shielded from the nucleus.*

c) State the trend in atomic radii of the elements occupying the same group.

- *Atomic radius increases down the group due to an extra shell of electrons added.*

Trend in metallic character

Metallic character depends on how readily atoms of elements lose their electron to form cations (positively charged ions).
Increase in atomic size increases the tendency to lose electrons, hence increasing the metallic character.
Decrease in atomic size decrease the tendency to lose electrons, hence decreasing metallic character.

Test it, fix it!

Did you know the trend of the following properties down the group and across the period?

Property	**Down the group**	**Across the Period from left to right**
Atomic size	Increases	Decreases
Tendency to lose electrons	Increases	Decreases
Matallic Character	Increases	Decreases

Trend in melting and boiling points of period 3 elements

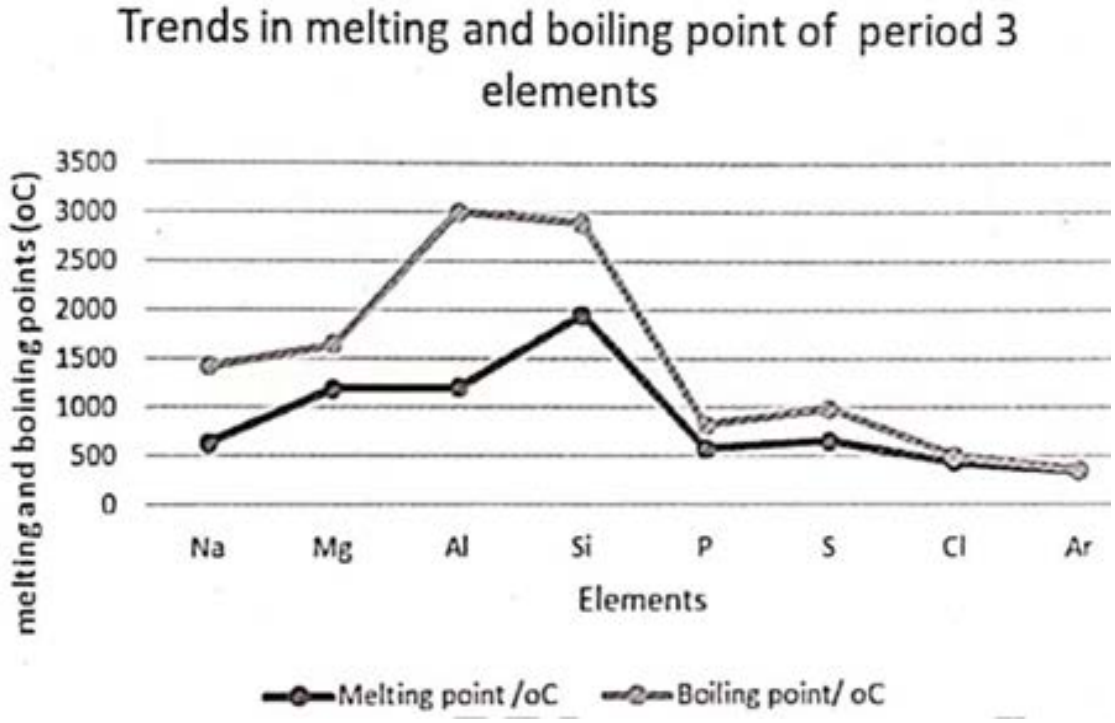
Melting point: is a fixed temperature at which a solid substance changes to liquid state.
Boiling point: is a fixed temperature at which the saturated vapour pressure of the liquid is equal to the atmospheric pressure.
Elements in different groups and periods exhibit different trends in the boiling and melting points.

Melting and boiling points depend on the strengths of forces which exist between the particles which make up a substance.

Melting and boiling points of period 3 elements.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Atomic number	11	12	13	14	15	16	17	18
Melting Point (^{0} C)	97.8	650	66.0	1410	441	112.8	-101.5	-189.4
Boiling Point (^{0} C)	882.8	1091	2470	2355	*280.5*	*444.6*	-34.04	-185.6

Representation on the graph



Description of the graph

Melting and boiling points increase among metals across the period and generally decrease among the non-metals

Factors which contribute to the observed trends on the graph

- Number of electrons in the outermost shell (for metals)
- Atomic radius
- Molecular size (for non-metals)

Draw a conclusion in respect to the melting and boiling points of the elements across period 3 and explain the trends.

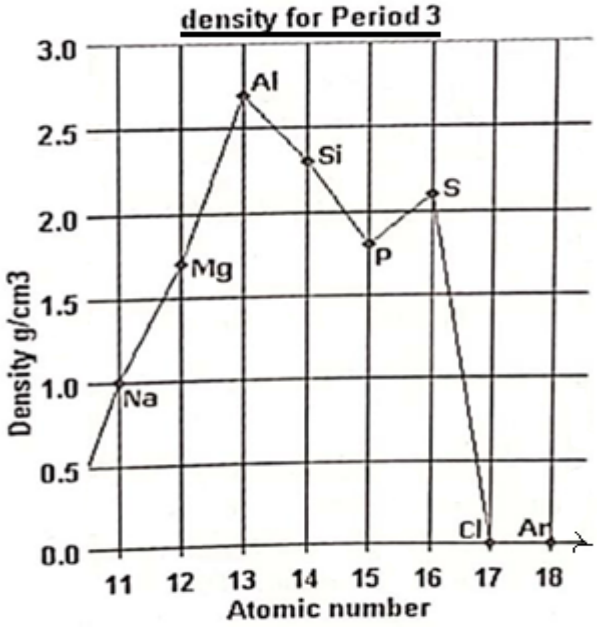
- The melting points and boiling points increase across the three metals because of the increasing strength of their metallic bonds.
- Silicon adopts a 3-dimensional structure with many interlinking covalent bonds that give it extra stability, hence the exceptionally high melting and boiling points.
- Phosphorous, sulphur and chlorine exist as molecules held by van der Waal's forces of attraction, whose strength increases with increase in molecular size.

How density varies across a period.

Trends in densities of the elements in period 3 of the periodic table

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Atomic number	11	12	13	14	15	16	17	18
Density (gcm^3)	0.97	1.74	2.70	2.33	1.82	1.96	0.0032	0.00178

Representation on the graph



Description/trends of densities with atomic numbers

- The densities of period 3 elements increase among metals and generally decrease among non-metals.

Explanation for the observed trend.

- Increase in densities from sodium to aluminium is due to decrease in atomic radii which favours the formation of stronger metallic bonds and hence closer packing of the atoms.
- Explain ko trend in densities for the non-metals across the period

Factors that contribute to the observed trends

- Atomic radius
- Strength of bonds.

Chemical properties of period 3 elements.

Reaction with oxygen

Each of the elements in period 3 reacts with oxygen to form an oxide. The reaction varies across the period.

Trial experiment

What is needed.

Phosphorus (white); Measuring cylinder; Aluminium foil; Universal indicator solution Deflagrating spoon; Bunsen burner; magnesium ribbon; distilled water; pen knife; sodium; petri dish; ruler; pair of tongs; dropper; sulphur; and gas jar

- The size of the sodium should be very small as burning large pieces would result in an explosion.
- White phosphorus catches fire when exposed to air.

Steps taken/what to do

1. Hold a piece of sodium using a clear dry pair of tongs and place it on a petri dish.
2. Cut a small piece of the sodium (the size of a grain of rice)
3. Place it on a deflagrating spoon and warm it gently until it starts to burn.
4. Lower it into a gas jar containing oxygen as shown in figure below
5. Remove the deflagrating spoon after the reaction stops.
6. Measure $10cm^3$ of distilled water and add it into the jar and shake. Add 3 drops of universal indicator solution into the jar and record observations.
7. Repeat steps 3 – 6 with a clean piece of magnesium ribbon (5cm long) and a small piece of aluminium foil and heat strongly before lowering them into a gas jar.
8. Repeat step 3 using a piece of white phosphorus but warm slightly.
9. Once the phosphorus starts smoking, remove fire and repeat steps 4 – 6.
10. Repeat steps 3 using half-filled deflagrating spoon of powdered sulphur. Heat until it starts burning before lowering it in a gas jar of oxygen.
11. Repeat steps 4 – 6 0nce

Analysis

Equations for the reactions

Sodium with limited oxygen

$4Na_{(s)} + O_{2(g)} \longrightarrow 2Na_2O_{(s)}$

Sodium with excess oxygen

$2Na_{(s)} + O_{2\,(g)} \longrightarrow Na_2O_{2\,(s)}$

Magnesium with oxygen

$2Mg_{\,(s)} + O_{2\,(g)} \longrightarrow 2MgO_{(s)}$

Aluminium with oxygen

$4Al_{(s)} + 3O_{2(g)} \longrightarrow 2Al_2O_{3(s)}$

Phosphorus with oxygen

$P_{4(s)} + 5O_{2(g)} \longrightarrow 2P_2O_{5(s)}$

Silicon with oxygen

$Si_{(s)} + O_{2(g)} \longrightarrow SiO_{2(s)}$

Sulphur with oxygen

$S_{(s)} + O_{2(g)} \longrightarrow SO_{2(g)}$

Conclusion

- Elements in period 3 react at different rates with oxygen under varied conditions.
- Sodium readily reacts with limited oxygen to form sodium oxide. Sodium burns in excess oxygen with a bright yellow flame to form a yellow solid of sodium peroxide.
- When magnesium ribbon is strongly heated, a vigorous reaction takes place. When magnesium ribbon is not cleaned, it takes time to start burning even when strongly heated because of the oxide coating.

- Aluminium also reacts with oxygen to form aluminium oxide. However, the reaction does not proceed further because of the formation of aluminium oxide coating.
- Phosphorus reacts with oxygen to form phosphorus pentoxide.
- Sulphur does not react with oxygen at room temperature but when heated, it slowly burns with a blue flame to form sulphur dioxide gas.
- Chlorine and argon do not react directly with oxygen.

Note;

- Period 3 elements, except chlorine and argon, react directly with oxygen to form different oxides.
- All the products are oxides.

Oxides of period 3 elements, their pH and nature/class.

Element	**Formula of Oxide**	**The pH of the oxide solution (Greater than or less than 7)**	**Class/nature of the oxide (Acidic, basic or amphoteric**
Sodium	Na_2O	Greater than 7	Basic
Sodium	Na_2O_2	Greater than 7	Basic
Magnesium	MgO	Greater than 7	Basic
Aluminium	Al_2O_3	Neutral	Amphoteric
Phosphorous	P_2O5	Less than 7	Acidic
Sulphur	SO_2	Less than 7	Acidic

Further explanation on Classes of oxides

An oxide is a compound of oxygen with another element. The following are major classes of oxides (types of oxides).

1. Basic oxides

These are oxides of metals which react with acids to form salt and water only. E.g. magnesium oxide, copper (II) oxide and calcium oxide

Magnesium oxide reacts with hydrochloric acid to produce magnesium chloride (salt) and water.

$$MgO_{(s)} + 2HCl_{(l)} \longrightarrow MgCl_{2\,(aq)} + H_2O_{(l)}$$

Copper (II) oxide reacts with sulphuric acid to form copper (II) sulphate (salt) and water.

$$CuO_{(s)} + H_2SO_{4(aq)} \longrightarrow CuSO_{4(aq)} + H_2O(l)$$

2. Acidic oxides

These are oxides of non-metals that dissolve in water to form acids. These oxides are called acid anhydrides. E.g. Carbon dioxide (CO2), Sulphur dioxide (SO2), sulphur trioxide (SO3), nitrogen dioxide (NO2) e.t.c.

Carbon dioxide dissolves in water to form carbonic acid

$$CO_{2\,(g)} + H_2O_{\,(l)} \longrightarrow H_2CO_{3\,(l)}$$

Sulphur trioxide reacts with water to form sulphuric acid

$$SO_{3\,(g)} + H_2O_{\,(l)} \longrightarrow H_2SO_{4\,(aq)}$$ (sulphuric acid)

These oxides react with alkalis to form salt and water. E.g. carbon dioxide reacts with sodium hydroxide to form sodium carbonate (salt) and water.

$$CO_{2\,(g)} + 2NaOH_{\,(aq)} \longrightarrow Na_2CO_{3\,(aq)} + H_2O_{\,(l)}$$

3. Neutral oxides

These are oxides of non-metals which do not show acidic or basic properties (they are neither acidic nor basic.). I.e., they don 't react with water to form acids and neither do they react with acids to form salts. E.g., carbon monoxide (CO), nitrogen monoxide (NO), dinitrogen oxide (N2O), water (hydrogen oxide).

4. Amphoteric oxides

These are metallic oxides which show both acidic and basic properties. i.e., they react with both acids and alkalis to form salt and water. E.g. aluminium oxides (Al_2O_3), lead(II)oxide (PbO), zinc oxide (ZnO).

Reaction of the amphoteric oxides with acids

Zinc oxide reacts with sulphuric acid to form zinc sulphate (salt) and water.

$ZnO_{(s)} + H_2SO_{4\,(aq)} \longrightarrow ZnSO_{4\,(aq)} + H_2O_{(l)}$

Aluminium oxide reacts with hydrochloric acid forming aluminium chloride (salt) and water.

$Al_2O_{3(s)} + 6HCl_{(aq)} \longrightarrow 2AlCl_{3(aq)} + 3H_2O(l)$

Reaction of amphoteric oxides with alkalis

Zinc oxide reacts with sodium hydroxide to form sodium zincate (salt).

$ZnO_{(s)} + 2NaOH_{(aq)} + H_2O_{(l)} \longrightarrow Na_2Zn(OH)_{4(aq)}$

Aluminium oxide reacts with sodium hydroxide forming a salt called sodium aluminate.

$Al_2O_{3(s)} + 2NaOH_{(aq)} + 3H_2O_{(l)} \longrightarrow 2NaAl(OH)_{4(aq)}$

5. Peroxides

These are oxides that contain twice as much oxygen as they would contain in their normal oxides. E.g., hydrogen peroxide (H_2O_2), Sodium peroxide (Na_2O_2).

6. Mixed oxides

These are oxides that react like a mixture of two simpler oxides. E.g., lead tetra oxide (Pb_3O_4) and Tri iron tetra oxide (Fe3O4).

Trend in physical and chemical properties of oxides of chlorides of period 3 elements.

Element	**Oxide**			**Chloride**		
	Formula	Class of oxide	Type of bonding	Formula	Physical State	Type of bonding
Na	Na_2O	Basic	Ionic	NaCl	Solid	Ionic
Mg	MgO	Basic	Ionic	MCl_2	Solid	Ionic
Al	Al_2O_3	Amphoteric	Covalent	$AlCl_3$	Solid	Covalent
Si	SiO_2	Acidic	Covalent	$SiCl_4$	Gas	Covalent
P	P_2O_3	Acidic	Covalent	PCl_3	Gas	Covalent
S	SO_2	Acidic	Covalent	S_2Cl_2	Liquid	Covalent
Cl	Cl_2O	Acidic	Covalent			

Reaction of period 3 elements with water

What is needed

Beakers	aluminium foil	knife
Sodium	sulphur	sandpaper
Petri dish	burning splint	Bunsen burner
Glass wool	tripod stands	pair of tongs
White phosphorus	delivery tube	magnesium ribbon
cold water		trough

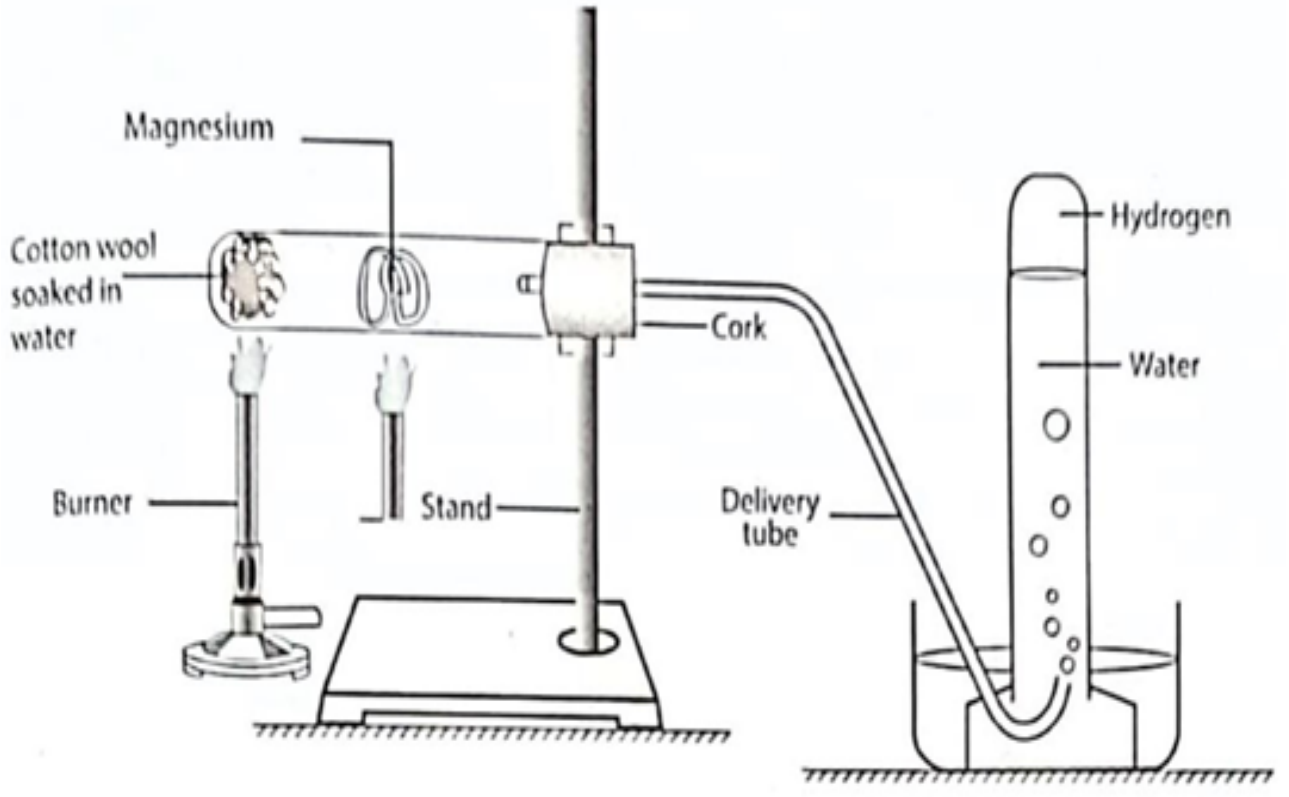
Safety precautions

The size of the sodium to be put in water should be very small, as large pieces would result in an explosion! Sodium reacts with water explosively.

What to do.

1. Hold a piece of sodium using a clean dry pair of tongs and place it on a petri dish.
2. Cut a small piece of the sodium (size of a rice grain) and put it in a beaker containing cold water.
3. Record your observations in a table.
4. Repeat steps 2 – 3 separately,using a small piece of magnesium ribbon, aluminium foil, white phosphorus and sulphur.
5. Put a clean piece of magnesium ribbon in a test tube to react with steam as shown in the figure below;

Illustration



Analysis, observation and conclusion

Element	Observation when the element is placed in cold water	Products formed
Sodium	Reacts Vigorously	Sodium hydroxide and hydrogen gas
Magnesium Ribon	Reacts very slowly with cold water	Magnesium hydroxide and hydrogen gas
Aluminium foil	Does not react with cold water Reacts vigorously with steam	Alominium Oxide and Hydrogen gas
White Phosphorouse	No observable change	-
Sulphur	No observable change	-

Trend of reactivity of period 3 elements with cold water

Trend: As you move across the period, the tendency to react with cold water decreases.

Note;

Chlorine is the only non-metal element in period 3 that reacts with cold water.

$Cl_{2(g)} + H_2O_{(l)} \longrightarrow HCl_{(aq)} + HOCl_{(aq)}$

Reaction with chlorine

Generally, the anhydrous chlorides of elements in the third period (except chlorine and argon) are prepared by heating the elements in dry chlorine gas or passing dry hydrogen chloride gas over the heated elements.

Reaction of white phosphorus with chlorine

What is needed	deflagrating spoon	petri dish	Pair of tongs
Gas jar	white phosphorus	water	cutting knife

Safety precautions

- White phosphorus catches fire when exposed to air
- Chlorine gas is poisonous, so wear a gas mask during the experiments.
- White phosphorus should not be heated before putting it in a gas jar of chlorine
- For student's safety, experiment should be strictly a demonstration in a fume cupboard.

What to do/steps taken/Procedure

1. Use a pair of tongs to put a piece of phosphorus on a petri dish with water.
2. Cut a small piece of the phosphorus (size of a rice grain) while still under water as shown in fig 1 and immediately lower it into a gas jar of chlorine as shown in fig 2.

Observation: (what happened when white phosphorus was lowered into the gas jar containing chlorine gas)

- It burnt spontaneously with a pale green flame.

Why was white phosphorus cut while under water?

- To prevent it from catching fire, had it been exposed to air

Write down the equation(s) for the reaction(s) that took place.

$P4_{(s)} + 6Cl_{2\,(g)} \longrightarrow 4PCl_{3(s)}$

$P4_{(s)} + 4PCl_{5(s)} \longrightarrow 10Cl_{2\,(g)}$

Reaction of other period 3 elements with chlorine

- Sodium burns in chlorine with a bright orange flame. White solid sodium

chloride is produced.

$2Na_{(s)} + Cl_{2(g)} \longrightarrow 2NaCl_{(s)}$

- Magnesium burns in chlorine with its usual intense white flame to give white magnesium chlide.

$Mg_{(s)} + Cl_{2(g)} \longrightarrow MgCl_{2(s)}$

- Aluminium is often reacted with chlorine by passing dry chlorine over aluminium foil heated in a long tube. The aluminium burns in the stream of chlorine to produce very pale yellow aluminium chloride. This sublimes (turns straight from solid to vapour and back again) and collects further down the tube where it is cooler.

$2Al(s) + 3Cl2(g) \longrightarrow 2AlCl3(s)$

- If chlorine is passed over silicon powder heated in a tube, it reacts to produce silicon tetrachloride. This is a colourless liquid which vapourises and can be condensed further along the apparatus.

$Si(s) + 2Cl_{2(g)} \longrightarrow SiCl_{4(s)}$

- If a stream of chlorine is passed over some heated sulphur, it reacts to form an orange pungent/irritating smelling liquid, disulphur dichloride.

$Cl_{2\,(g)} + S_{(s)} \longrightarrow S_2Cl_{2\,(l)}$

The order of reactivity from the most reactive is; Na> Mg> Al> Si> S.

Sample questions

1. Write the equations for the reactions of chlorine with;
   (i) Sodium
   (ii) Magnesium
   (iii) Aluminum
   (iv) Silicon sulphur
2. Copy and cmplete the table below

Element	Formula of the Chloride formed by the element
Sodium	
Magnesium	
Aluminium	
Silicon	
Silicon	
Sulphur	

3. (i) Arrange the elements, starting with the most reactive one.
   (ii) Give reasons to support your arrangement.
4. How are the chlorides of the elements in the table you have obtained prepared?

Physical and chemical properties of elements in Group I
Physical properties of group I elements

Group I elements occupy the first column on the far left of the periodic table. These elements are also called alkali metals.
The alkali metals share similar physical and chemical properties.

The general phsical properties include;

- The metals are soft and can be cut with a knife. The softness decreases down the group.
- Their melting and boiling points are low. The melting point decreases down the group. They have low densities and can float on water.
- They have shinny surfaces when freshly cut. The shinny surfaces soon tarnish due to reaction with oxygen to form the oxides.
- They are good conductors of electricity and heat.
- They do not possess tensile strength to any appreciable extent.

Changes in the physical properties of group I elements

- At this level, we shall look at the trend in the following phsical properties;
- Melting and boiling points
- Hardness
- Densisties

Trends in the melting and boiling ponits.
Melting and boiling points of group I elements.

Element	Melting Point (^{0}C)	Boiling Point (^{0}C)
Lithium	180.5	1342
Sodium	97.8	882.8
Potassium	63.5	758.8

Trial questions from the above table

1. Discuss how the melting and boiling points of group I elements vary down the group.
2. Briefly explain what causes the above variation

Trend in hardness of metals in group I

What is needed.

Knife or razor blade
Pair of forceps
Lithium metal
Sodium metal
Potassium metal
Dry white tile
Plastic gloves

Safety precaution

Ensure that you have the gloves on throughout the experiment. Wrap the remaining piece of metal properly in polythene, then store it under paraffin

What to do/steps taken.

1. With a pair of forceps, pick the sodium metal from the bottle and place it on the dry white tile.
2. Using a knife or razoe blade, cut the sodium metal as shown in figure.
3. Repeat steps 1 – 2 for potassium and lithium metals.

Observation

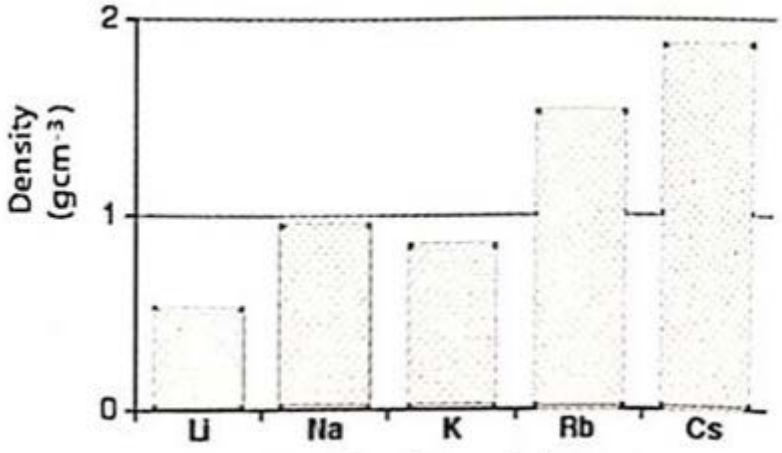
Potassium was the easiest metal to cut.
The metals are soft and appear slivery white and shiny.
They are highly reactive and can easily react with air when left in an open place.

Sample question

Explain the trend in hardness of the group I elements..

Trend in densities of group I elements

Consider the graph below



Densities of Group I elements

Worked questions

1. Describe the trend in the density of group I elements.
   Generally, the densities of group 1 elements increase down the group.
2. Identify the elements that are most likely to float on water. Give a reason for their answer. (hint the density of water is 1 gcm^{-3})
3. Lithium, sodium, potassium, are more likely to float on water since their densities are less than 1 gcm^{-3}

Chemical properties of group I elements

Reaction of group I elements with oxygen

What is needed	lithium metal	sodium metal potassium metal
Pair of tongs Knife Deflagrating spoon bunsen burner petri dish		

The size of the metal to be heated should be very small, as burning large pieces would result in an explosion.

Safety precaution

What to do/steps taken

1. Hold a piece of lithium metal using a clean, dry pair of tongs and place it on a petri dish.
2. Cut a small piece of the lithium (the size of a rice grain) metal
3. Put the cut piece of lithium on a deflagrating spoon and heat it until it starts to burn.
4. Record your observation.
5. Repeat steps 1– 4 using sodium and potassium metals instead of lithium.

Observation

Group I metals	Observation	Colour of the flame
Lithium	White solid formed	Intense red flame
Sodium	White solid formed	Bright yellow flame
Potassium	White crystalline solid formed	Pale purple flame

Equations for the above reactions

$4Li_{(s)} + O_{2\,(g)} \longrightarrow 2Li_2O_{(s)}$

$4Na_{(s)} + O2(g) \longrightarrow 2Na_2O_{2\,(s)}$

$4K_{(s)} + O2_{(g)} \longrightarrow 2K_2O_{(s)}$

$4\ Rb + O2_{(g)} \longrightarrow 2Rb_2O_{(s)}$

Reaction of group I elements with cold water

What is needed

Glass beakers
Pair of forceps
Gloves
cold water
lithium metal
litmus paper (red and blue)
sodium metal
potassium metal

Safety precaution

The size of the metal to be put in cold water should be very small, as large pieces would result in an explosion.

What to do

1. Fill the beaker with water until it is half full.
2. Using a pair of forceps, pick a sample of lithium metal and then drp it in the beaker.
3. Record your observations.
4. Test the resulting solution with litmus paper (red or blue, but separately)
5. Repeat steps 1 – 4 with samples of sodium and potassium metals.

Observation

Group I Metals	Observation on dropping the metal in water	Is the reaction vigorous, very vigorous or explosive?	Effect of the resultant solution on the litmus paper
Lithium	Lithium floats and a steam of colourless gas is produced	Vigorous	Turns red litmus paper blue
Sodium	Darts on the surface of water and melts into a silvery ball Bubbles of a colourless gas which gives a pop sound with a burning splint is produced when sodium darts in water	Very vigorous	Turns red litmus paper blue
Potassium	Darts on the surface of water and melts into a silvery ball Bubbles of a colourless gas is produced which ignites spontaneously. As the potassium melts, the vapour produced burns with a pale purple flame.	Explosive	Turns red litmus paper blue

Note; The reactivity of alkali metals with cold water increases as you move down the group.

Equations for the reactions

$2Li_{(s)} + 2H_2O_{(l)} \longrightarrow 2Li_{(aq)} + H_{2(g)}$

$2Na_{(s)} + H_2O_{(l)} \longrightarrow 2NaOH_{(aq)} + H_{2(g)}$

$2K(s) + 2H_2O_{(l)} \longrightarrow 2KOH_{(aq)} + H_{2(g)}$

Reaction of group I elements with chlorine

The alkali metals react with chlorine to form metal chloride salts. E.g.,
Lithium burns with a red flame to produce white fumes lithium chloride.

$2Li(s) + Cl2(g) \longrightarrow 2LiCl(s)$

Note;

When hot lithium is lowered into a gas jar of chlorine, lithium bursts into a flame. Sodium continuous to burn in chlorine with a yellow flame to form white fumes of sodium chloride.

$Na(s) + Cl_{2\ (g)} \longrightarrow NaCl_{(s)}$

Potassium burns in chlorine with a pale purple flame to form fumes of potassium chloride.

$K(s) + Cl_{2\ (g)} \longrightarrow KCl_{(s)}$

Similarities in the chemical properties of lithium, sodium and potassium.

- They all produce hygrogen gas when reacted with water.
- They all react with chlorine gas to form metal chlorides
- They produce oxides when burnt in oxygen gas.

Relationship between the chemical properties of Group I elements with their electron arrangement.

Sample questions

1. What are the colours of the flames produced when group I elements burn in chlorine gas?
2. What happens when hot lithium is lowered into a gas jar of chlorine? 3. What is the product formed when an alkali metal react with chlorine?
4. Write equations for the reactions between alkali metals and chlorine gas.

Chapter summary

- The Periodic Table is a tabular chart that shows the arrangement of chemical elements in order of their atomic number, in rows and columns, so that elements with similar atomic structure (and hence similar chemical properties) appear in the same column (group).
- When arranged by atomic number, the elements show periodicity.
- All atoms of elements in the same group have the same number of electrons in their outermost energy levels. So, all elements in a group have similar reactions, because they have the same number of valency electrons.
- The period number tells you the number of energy levels in an atom.
- The arrangement of elements in the Periodic Table gives rise to trends in the properties of the element. For example, across a period, metallic character decreases.
- All the elements of Period 3, except chlorine and argon, combine directly with oxygen to form oxides.
- All the elements of Period 3, except argon, combine directly with chlorine to form chlorides.
- Elements in Group I are very reactive, and great care needs to be taken when carrying out experiments involving these elements—as the reactions can be explosive.

Sampleactivityof integration(useother textbooks fromyourlibrary toseeother sample AOIs).

Health agencies have rported about how life expectancies, especially in developing countries have lowered over time. It is known that some materials like plastics, used in handling, holding and storage of food, disintegrate into food to a certain extent. Reports show that continuous use of such materials exposes thehuman body to cancer risks and other diseases.

Task;

As a chemistry learner, report to a village health team (VHT) about the materials which are suitable for use in the food industry.

In your report;

a) Include information on the elements used to make food containers and other food packaging materials.

b) With reference to group I and group II elements, explain why some elements are not used in the food industry (for example, not in the manufacture of food-storage materials)

Sample questions

1. Use the words given in the brackets to complete the sentences below.
   (vertical, left, eight, seven, increase, horizontal, right)

Elements are arranged in the Periodic Table from..... to ..... according to ..... in atomic number. The Periodic Table is comprised of ..... periods and .....groups, in which periods are the ..... rows whereas groups are the .....columns.

2. a) What is boiling point?
   b) Explain why the boiling points of the elements from sodium to aluminium increase across the period.
   c) Explain why silicon has a high melting point.
   d) Explain the changes in the melting points of the elements from phosphorus to argon.

3. a) Why are Group I elements soft and malleable?
   b) Would you expect the alkali metals to have high densities and relatively low melting points? Give reasons for your answers.
   c) Explain why sodium has a higher density than lithium.